SPECIES COMPOSITION AND ECOLOGICAL RELATIONSHIPS OF ICTHYOFAUNA ON ARTIFICIAL LIBERTY SHIP REEFS OFF PORT ARANSAS, TEXAS

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ABSTRACT

Five cruises were made to the Liberty Ship Reef off Port Aransas, Texas in June and July 1978. Collecting procedures, which included sampling by fish trap, hook and line, and long line, were relatively unchanged from previous trips. Increased diver participation allowed more reliable placement of the traps onto the deck of the ships. Diver observations of fish greatly supplemented other data collecting methods.

Fishes collected or observed on the ship reef were divided into four ecological groups: 1) obligate reef fishes which are demersal and almost always associated with natural or artificial structures, 2) coastal pelagic species which are attracted to structures for orientation, 3) estuarine-dependent opportunistic species which exploit the reef for food and shelter but are not confined to that habitat, 4) typical continental shelf species which occur near the ship reef but are not actually associated with it.

At this time of year the Liberty Ship reefs support a large and diverse fish fauna, composed of both predator and prey species, and appears to have many characteristics of a complete reef habitat with an abundance of catchable sportfish.

I. INTRODUCTION

The primary research goals of this study are to determine which fish species inhabit the Liberty Ship reefs at different seasons and to determine why various fish species are attracted to such structures. While not providing a complete and exhaustive answer to these questions, this concluding report for the first study period distinguishes several ecological groups of fishes that commonly inhabit the artificial reef and presents some reasons why each group is attracted to the ships, based on stomach content, diving observations and capture information. Increased foraging opportunities and thigmotropism (the attraction of fishes to solid objects regardless of food availability (Breder and Nigrelli, 1938) are the primary attractive factors while predator avoidance appears to play a lesser role. The energetic savings afforded by periodically moving behind a baffling structure to avoid swimming against a current ("sheltering behavior") may also play an important role in areas of strong currents prevailing at the Liberty Ships reef.

To sample fish populations more completely on the ships themselves, placing of fish traps on the decks of the Liberty Ships during the June-July sampling period was imperative. Strong currents, variable and often poor visibility, the decompression restraints of repetitive diving to 85-110 ft. and the large number of holes and snags on the decks of the ships made the development of a safe, efficient method for trap installation and removal of utmost concern. A satisfactory method was developed and the traps were successfully placed on the decks of the ships on two sampling cruises.

Additional sampling methods tested included a 1500' longline, glass minnow traps and artificial baiting of the traps.

II. METHODS

A complete description of the construction method, dimensions and a diagram of the fish traps was presented in the previous report (Vetter and Roels, 1978). A description of the method for deployment of the traps onto the bottom was also presented in the initial report. To place the traps safely onto the decks of the ship requires a more coordinated and precise effort between divers and the research vessel, and was accomplished as follows.

The 85 ft. R/V Longhorn was maneuvered over the ships and a steel hydrographic cable with a 200 lb. weight was lowered onto the deck of a liberty ship. A trap was then tethered to the hydrographic cable and lowered via the trap buoy line to within five feet of the deck of the submerged ship. The anchored cable insures that regardless of how the research vessel swings and regardless of cross currents the traps will track to the decks of the submerged ship without the aid of or endangering of the divers. A team of divers descends and removes the tether line from the cable. Personnel aboard the research vessel pay out the remaining trap line while the divers walk the trap along the deck to the desired location. While the divers are away placing the first trap, another trap is lowered on the cable. This procedure continues until all the traps are placed.

Longline fishing gear consists of 1500 ft. of 1/4 inch hard wrapped nylon longline with anchors and buoys at both ends. 150 baited hooks are attached to the longline with releasable

halibut clips. Hooks are placed on the line at approximately ten foot intervals and the line is then suspended just above the sea floor with 5" fishing floats to prevent fouling of the baits. The longline is fished for 2 hour intervals and retrieved with the aid of a shipboard winch.

Commercially obtained minnow traps are 1 gallon glass jars with three tapering glass entrance cones having final entrance portal diameters of 7/8 in. These traps are intended to catch small invertebrates and tropical fish not retained by the larger mesh traps.

Artificial trap baits are 6 to 18 in. aluminum "fish" suspended in series of five from the top to the bottom of the traps on monofilament line. The "fish" turn and flash in the current providing a visual stimulus similar to the school of Trachurus lathami and Decapterus punctatus that inhabit the reef.

III. RESULTS

Five cruises were conducted during the June-July sampling period; four to the Liberty Ship reefs, and a fifth as a comparative sampling cruise to a natural reef of equivalent depth. The natural reef chosen for comparison was Steamer Rock, a pleistocene reef outcropping or consolidated shell ridge located in 87 ft. off Port Mansfield, Texas. It projects up ten feet from the sea floor and extends for approximately 800 feet. The Loran coordinates are 3H31490, 3H23864. It is the only naturally occurring reef located in a depth comparable to the Liberty Ship reefs that was easily accessible from Port Aransas, Texas.

The bottom temperature at the Liberty Ship averaged 20.5 during June and 23.5°C during July. The surface temperature was 28°C. Salinity remained at 35.5°/oo throughout. Traps were placed on the decks of the ship only on the two July cruises. The decks of the ships are at 85 ft. while the bottom is 110 ft. Visibility was always much greater on the decks of the ships than on the bottom due to the presence of a turbid nepheloid layer. Visibility varied from 5-70 ft. on the decks of the ships while on the bottom visibility never exceeded 5 ft. Winds varied from 1-15 knots during June-July cruises with average wave heights of 1-4 ft.

A complete list of species observed or collected from the artificial reefs is presented in Table 1. A comparison of the relative abundance and diversity of trap-susceptible species on or at various distances from the ships is presented in Table 2. There is no doubt that the artificial reefs attract fish; this is dramatically illustrated in Figure 1 plotting the fish catch in identical traps at increasing distance from the ships (Figure 1). A summary of the stomach contents of the more abundant fish species and trophic interactions between members of the reef community are presented in Table 3.

The largest number of individuals taken in a trap was 134 during July, with a 48 hour set on the bottom adjacent to the ships. The largest total weight was 25.48 kilos for the same sample. The largest individual taken during June-July was a red snapper weighing 5.9 kilos in a trap 250 ft. away from the ships.

IV. DISCUSSION

a. Discussion of sampling methods

Two major changes were made from the winter sampling period; traps were placed on the decks of the ships and visual observations by divers were made of the biotic community associated with the artificial reefs. Six biologist-divers examined the reefs, listed the species and reached general impressions about the reefs. Over 50 dives were made during June-July, 1978.

Diver observations yielded a greater number of fish species than any other method: 23 species were siezed by diving; 11, hook and line; 7 by trap; 6 by long-line. Under ideal conditions, diving is clearly superior to provide a qualitative impression of which species occur around the reefs. Quantitative census methods (Jones and Thompson, 1978) have also been developed. However, turbidity and currents which can vary visibility hourly make this method less acceptable than traps for providing comparative quantitative estimates of abundance and species composition of fish on the Liberty Ship reefs.

Development of a technique for safely and efficiently placing the traps on the decks of the ships has been the most important change in the sampling procedure. Prior to this all traps were submerged in the nepheloid layer which persists immediately above the benthic sediments and no <u>in situ</u> observations of the traps' performance were possible. Based on visual observation, traps seem to capture and retain fish for the reasons postulated in the winter report (Vetter and Roels, 1978). In general, fish in the traps seem to have no idea that they are trapped and appear to orient themselves into the prevailing current as if they were not trapped. The greater catch rate of traps placed on the decks

at 85 ft. depth versus those off the ships in 110 ft., (31.2 individuals per trap versus 12.7 individuals per trap) may be a function of increased thigmotrophic response due to greater visibility as well as increased real abundance.

In a sense, fish traps act as an artificial reef structure themselves and many of the postulated reasons why fish are attracted to traps (including their role as a food source, thigmotrophism, and con-specific attraction) are similar to those suggested to explain fishes' attraction to artificial reefs. Munro et at (1971) observed little or no difference between baited and unbaited traps in terms of the numbers and species taken but did obtain larger fish in baited traps. Craig (1976) and Munro et al (1971) emphasize the importance of thigmotrophism and con-specific attraction as primary agents in catch composition. Fish taken in this study with baited traps were examined to determine if they had consumed bait in the traps. Lagodon rhomboides (pinfish) consumed more bait than any other species trapped, containing 85% bait and 93% bait during the winter and summer periods. Lutjanus campechanus (red snapper) contained 39.77% bait in winter and 12.50% bait in the summer. To determine if catch composition could be altered by bait type, one trap was baited with artificial bait. This trap contained 8 snapper and 2 pinfish while three baited traps placed in similar locations on the decks of the ships averaged 3.6 snapper and 88.6 pinfish. The increased percentage of snapper may be related to con-specific attraction and founder

effects (Munro, 1974) as well as bait type and further experiments with baited and unbaited traps are planned.

Longlining as a sampling method produced mixed results. The long lines have not yet been successfully deployed close enough to the ships to capture reef species. One end of the line is anchored near the ships and the remaining line is payed out with the current. Although the line has not produced typical reef-associated fishes, it has provided valuable supplemental information on the type of bottom feeding fishes that inhabit the mud bottom surrounding the ships. Deploying the longline on or alongside the ships is precluded by the problem of snagging on submerged obstructions. 1000' of a 1500' longline were lost due to entanglement on a comparative sampling cruise to Steamer Rock.

b. Discussion of the biological community on the artificial reefs

An assessment of the amount of epifaunal covering and biomass was never an objective of the current study. However, as this benthic community serves as a food source and shelter to some species inhabiting the reefs, a general impression of the benthic community will be presented. About 80% of the outer surface area of the ships (as estimated by 6 biologist-divers) remains devoid of obvious macro encrusting organisms. A thin layer of diatoms, bryazoans, sponges, and other micro and barely macroscopic fouling organisms are generally present over the entire deck of the ships. Barnacles, Balanus reticulosus, are confined to areas of high water flow, primarily the gunwales and rims of holes in the deck. Sea urchins and Thais graze the layer of detritus that covers the decks. The remainder of the decks is only occasionally colonized by sessile

invertebrates such as gorgonia coral, stony coral, slipper shells, winged oysters and spiny oysters. Macro algae were completely absent from the ships. The apparent low levels of attached growth may be the result of low light intensity and scouring by currents or intense grazing pressure from fish and marine invertebrates. If the latter is the case the reefs may be highly productive yet retain a low standing stock. To determine the grazing pressure on the attached fouling community, wire cages that exclude fishes and grazing invertebrates will be placed over areas of the deck and the amount of growth in the absence of grazing pressure will be measured.

The families and species of fish recorded from the Liberty Ships are in keeping with those reported from other natural and artificial reefs in the northern Gulf of Mexico, (Hastings, Ogrum and Mabry, 1976; Sonnier et al, MS) and at the family level with those in the Caribbean, (Munro et al, 1971; Fast, 1974; and Craig, 1976). The Scaridae, parrot fishes, have not been observed on the Liberty Ship reefs probably due to the low abundance of coral, their primary food source.

The primary goal of this research has been to ascertain which fish species inhabit the Liberty Ship reefs and their reasons for utilizing it. The families of fishes that associate with the ships can be divided into four ecological groups: (1) obligate reef fishes, that are demersal and almost always associated with natural or artificial structures (2) coastal pelagic species, that are drawn to structures to orient themselves in the water column regardless of the presence or absence of attached growth,

(Klima and Wickham, 1971) (3) estuarine-dependent opportunistic species that will exploit a reef for food or shelter but are in no way confined to that type of habitat alone (4) typical species of the continental shelf that occur near the ships but are in no way associated with it.

Group one, obligate reef fish, are perhaps the most important from a recreational fishing and diving point of view. It includes those species that are characteristic of natural coral and rock reefs throughout the Gulf of Mexico and the Caribbean. These fish utilize the reef community as a source of food and are usually closely associated with the reef itself. The Serraidae, represented by Warsaw grouper, jewfish, scamp, rock sea bass, and belted sand fish, and the Lutjanidae, represented by red snapper, are predators on the reef while the families Chaetodontidae (reef butterflyfish, queen angelfish), Ephippidae (spadefish), Pomacentridae (cocoa damselfish), Balistidae (grey triggerfish), and Labridae (slippery Dick) are gleaners and foragers on the artificial reef. All of these species except for juvenile red snapper are rare or absent from trawl collections made in the surrounding area during the Bureau of Land Management's Outer Continental Shelf Survey (1975, 76, 77).

The second ecological group includes those coastal pelagic species that display a strong thigmotrophic reaction to structures or those larger pelagic species that prey on such schooling bait fish, these species are a major component of the summer fauna on the Liberty Ships. Klima and Wickham (1971), working in the northeastern Gulf of Mexico, suspended artificial structures devoid of any biological growth, and recorded which species and to what degree

they associated with the structure. They found that round scad, Spanish sardine, scaled sardine, amberjack, rainbow runner and blue runner were most prominently associated with such structures. Upon removal of the structure the schooling fish began an outwardly spiralling elipitcal path in search of another object. Around the Libery Ships similar coastal pelagic species behaved in this way. The Carangidae, represented by the rough scad, round scad, rainbow runner and blue runner, and the Clupeidae (scaled sardine) were the dominant coastal pelagic species orienting to the reefs. None of these species have been taken in traps and these fish are usually observed in the upper water column. The larger barracuda were mentioned only casually by Klima and Wickham (1971) and ling also seem to exhibit a thigmotrophic attraction to the ships while remaining in the upper water column.

The third ecological group, estuarine-dependent opportunistic species found in a wide variety of habitats including Liberty Ships, are perhaps the most seasonally variable. The Sciaenidae, represented by the sand trout and golden croaker are most abundant in the winter when they migrate from the estuaries onto the continental shelf. The Pomadasyidae or grunts, represented by the pigfish and the Sparidae or porgies, represented by pinfish and sheepshead, are common both winter and summer. Based on diel observations of pigfish around an oil rig (Hastings et al) and stomach content information gathered during this study, it appears likely that sandtrout, croaker and pigfish rely primarily on the artificial reefs for shelter while foraging away from the ships while pinfish and sheepshead normally associated with jetties and pilings definitely exploit

the reefs themselves as a food source (see Table 3).

The remaining group comprises those species typical of most of the surrounding continental shelf and are probably not associated with the reefs except accidentally. This group includes the eels, Ophichthidae, and Muraenidae, the sharks and other species recorded in Table 1.

In summary, the Liberty Ship reefs at this time of year support a large and highly diverse community of fishes. Schools of scad and sardine numbering in the millions occur there, providing an abundant food supply for the larger species (Table 3). Red snapper form large schools and Warsaw grouper are commonly encountered in the course of a normal 20 minute dive.

V. COMMENTS, NOTES, AND SUGGESTIONS

1) The ships have shifted and the original diagram presented in Vetter and Roels (1977) is no longer accurate. The two inshore ships (the Weiser and the Dana) are now lying bow to stern with the more southerly ship inshore.
2) Fish, especially snapper, do not appear to move away from the ships. Fishing success is almost entirely related to the anglers ability to position his boat directly over the ships.
3) Predator exclusion cages should be placed over small areas of the deck to determine the true productivity of the ships when continual cropping by grazers is excluded.
4) Comparison of baited and unbaited traps should be continued, to determine whether this affects catch size and composition.
5) Gill nets should be suspended over the decks of the ships to better sample the more pelagic schooling species.

6) The species-time random count technique proposed by Jones and Thompson (1978) should be attempted to quantify the fish stocks encountered by divers.

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Table 1. Species occurring on Liberty Ship reefs during June-July 1978

	Family Species	Common Name	Method of Capture or Observation
I	Serranidae	(groupers,sea basses)	
	Epinephelus nigritus	Warsaw grouper	D,H-L
	Epinephelus itajara	jewfish	D
	Mycteroperca phenax	scamp	D
	Centropristis philadelphica	rock sea bass	H-L
	Serranus subligarius	belted sand fish	D
	Lutjanidae	(snappers)	
	Lutjanus campechanus	red snapper	D,T,H-L
	Chaetodontidae	(butterflyfishes,angelfishes)	
	Chaetodon sedentarius	reef butterflyfish	D
	Holacanthus ciliaris	queen angelfish	D
	Ephippidae	(spadefishes)	
	Chaetodipterus faber	Atlantic spadefish	D
	Pomacentridae	(damselfishes)	
	Pomacentrus variabilis	Cocoa damselfish	D
	Balistidae	(triggerfishes)	
	Balistes capriscus	grey triggerfish	D,T
	Labridae	slippery dick wrasses	
	Halichocres bivittatus		D
II.	Clupeidae	(herrings)	
	Harengula pensacolae	scaled sardine	D
	Carangidae	(jacks)	
	Decapterus punctatus	round scad	D,H-L
	Trachurus lathami	rough scad	D,H-L
	Caranx fusus	blue runner	D
	Eliagatis bipinnulata	rainbow runner	D

Table 1. cont.

	Family Species	Common Name	Method of Capture or Observation
	Rachycentridae	(ling)	
	Rachycentron canadum	ling,cobia	D,H-L
	Sphyraenidae	(barracudas)	
	Sphyraena barracuda	greater barracuda	D
III	Sciaenidae	(croakers,seatrouts)	
	Micropogon undulatus	golden croaker	T
	Synoscion arenarius	sand seatrout	H-L
	Equetus umbrosus	cubbyu	D,T
	Sparidae	(porgies)	
	Lagodon rhomboides	pin fish	D,H-L,T
	Archosargus probatocephalus	sheepshead	D
	Pomadasyidae	(grunts)	
	Orthopristis chrysoptera	pigfish	D,T,H-L
IV	Ophichthidae	(snake eels)	
	Ophichthus gomesi	shrimp eel	LL *
	Ophichthus sp.	banded shrimp eel	T
	Muraenidae	(moray eels)	
	Gymnothorax ocellatus	ocellated moray*	LL
	Batrachoididae	(toadfishes)	
	Opsanus beta	Gulf toadfish	LL,D
	Tetraodontidae	(puffers)	
	Sphaeroides sp.	puffer	D

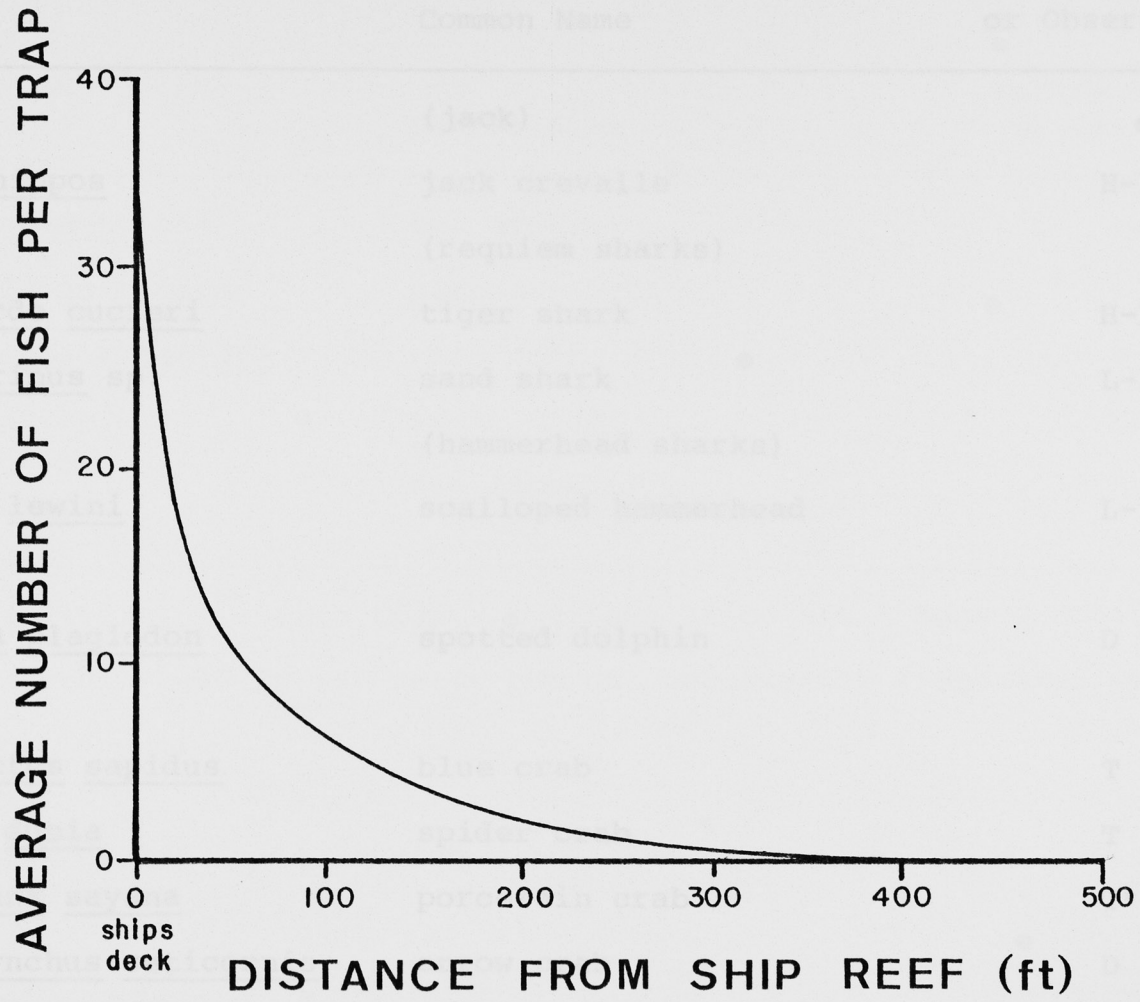

Figure 1. Average number of individuals per trap at various distances from the ships

Table 1 (cont.)

Family Species	Common Name	Method of Capture or Observation
Carangidae	(jack)	
Caranx hippos	jack crevalle	H-L*
Charcharinidae	(requiem sharks)	
Galeocerdo cucieri	tiger shark	H-L,LL*
Charcharinus sp.	sand shark	L-L*
Sphyrnidae	(hammerhead sharks)	
Sphyrna lewini	scalloped hammerhead	L-L*
Mammals		
Stenella plagiodon	spotted dolphin	D
Invertebrates		
Callinectes sapidus	blue crab	T
Libinia dubia	spider crab	T
Porcellana sayana	porcelain crab	T**
Stenorhynchus seticornis	arrow crab	D
Stenocionops furcata		T
Murex fulvescens	spiny murex	D
Thais haemastoma	rock shell	D
Pteria colymbus	winged oyster	D
Spondylus americanus	spiny oyster	D
Balanus reticulatus	barnacle	D

Table 1 cont.

Family / Species	Common Name	Method of Capture or Observation
Arbacia punctulata	sea urchin	D,T
Crepidula fornicata	slipper shell	D
Leptogorgia virgulata	whip coral	D
Astrangia sp.	stone coral	D
	sea cucumber	D

1) D = diver observation, T = fish trap, LL = long line, H-L = hook and line

* species taken within 2000 ft. of reefs but not necessarily associated with reefs

** epizoic on *Libinia dubia*

Table 2. Abundance and diversity of fishes occurring in traps at various distances from the reefs during June-July, 1978.

Location of Trap	# of samples (24 hr.)	Abundance*	Diversity**	Species Occurring	# of Individuals
on deck (85 ft. depth)	10	31.20	.60	Lutjanus campechanus	30
				Lagodon rhomboides	269
				Orthopristus chrysopterus	8
				Micropogon undulatus	1
				Balistes capriscus	3
				Equetus umbrosus	2
0-30 ft. from ship (110 ft. depth)	11	12.73	.45	Lagodon rhomboides	132
				Lutjanus campechanus	4
				Orthopristis chrysopterus	2
				Micropogon undulatus	1
				Ophichthus sp.	1
250 ft. from ship	3	.33	.33	Lutjanus campechanus	1
500 ft. from ship	1	0.00	0.00		

* Abundance = average # of individuals per sample

** Diversity = average # of species per sample

Table 3. Stomach contents of fishes inhabiting the Liberty Ship Reefs during June-July *

Species	Total # Examined	# Empty	Diet Item	% of Diet
Ephinephelus nigritus (Warsaw grouper)	2	0	unidentified+bait	40.00
			pinfish	25.00
			round scad	25.00
			blue crab	10.00
Lutjanus campechanus (red snapper)	40	32	blue crab	26.25
			round scad	25.00
			squilla	16.25
			unidentified+bait	12.50
			pinfish	3.75
			red snapper	3.75
Orthopristis chrysopterus (pigfish)	10	7	post larval crabs	33.33
			fish eggs	33.33
			detritus, shell debris and sediment	33.33
Lagodon rhomboides (pinfish)	57	2	bait	93.00
			sea urchin	3.50
			shrimp	3.50
Micropogon undulatus (golden croaker)	2	2		

* Insufficient data are available about the diet of other species listed in Table 1.